Controversies relating to pre-participation cardiovascular screening in young athletes: Time for a realistic solution?

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The sudden death of any young individual is a tragic event that causes immeasurable damage to family lives. The sudden death of a young athlete from a cardiac disorder is particularly emotive and is often associated with considerable media coverage, drawing attention to the youth and athletic prowess of the individual and the number of life years lost consequent to a cardiac disorder that could have been detected during life. Most exercise-related sudden cardiac deaths are attributed to congenital or hereditary cardiac disorders that are asymptomatic in the vast majority of victims.\textsuperscript{1,2}

Unsurprisingly, the death of a young athlete often galvanises urgent discussions relating to pre-participation cardiac screening (PPS) involving members of the community, sports physicians and sporting governing bodies.

There is considerable resistance to implementing widespread cardiac screening of athletes. The low incidence of deaths and the low prevalence rates of all implicated disorders challenge the cost efficacy of such a programme. Furthermore, there are concerns relating to the overlap between the physiological adaptation to exercise and cardiac disease resulting in false positive results and unnecessary anxiety or even disqualification of an athlete from future competitive sport.\textsuperscript{3} It is also recognised that up to 11\% of deaths in athletes occur at rest therefore, cessation of sport will not necessarily prevent death in all athletes.\textsuperscript{1} Finally, there are issues relating to the lack of infrastructure and expert personnel trained in athlete’s heart as well as the broad phenotype of the heterogeneous disorders implicated in the sudden death of an athlete. The UK and many other Western countries do not favour screening of athletes. Indeed screening of athletes in the UK is confined to
elite sporting organisations such as the Premier League football association and the Lawn Tennis Association who mandate independently financed screening programmes in all youth athletes.

In the US and Italy PPS programs are in existence to minimise the risk of sudden death due to cardiac disorders in young athletes. The US programme utilises a health questionnaire relating to cardiac symptoms and a family history of premature cardiac disease as well as physical examination of the cardiovascular system. Unfortunately the reputation of such basic screening programmes have been jeopardised by American physicians holding international expert status in sports cardiology studies which have emphatically demonstrated an extremely poor yield in identifying athletes with fatal disorders.

In Italy, a state sponsored screening programme has been in place since the late 70s and includes a health questionnaire, cardiovascular physical examination and 12-lead ECG. The Italian experience from Veneto has shown that screening with ECG has reduced the death rate in athletes from 4.19/100,000 person-years to 0.43/100,000 person-years, equating to a reduction of approximately 90%. The data has received immense publicity and is considered the gold standard paradigm for low cost and effective cardiac screening in young athletes. The impact of the number of life years saved is laudable and would be considered a health service boost if similar number of life years were preserved in individuals in the fifth decade onwards. The reduction in these deaths was associated with a 7% of individuals
requiring further investigations due to false positive tests and the disqualification of 2% of all athletes screened predominantly due to hypertension, cardiac conduction tissue disease and valvular heart disease. Most disqualifications are on anecdotal grounds and lack evidence based credibility.

Unfortunately, there are no data from other European countries in the literature relating to screening young athletes that are of comparable in magnitude to the Italian data, which can be simply explained by the fact that screening competitive athletes is not mandatory in most countries. Elston et al extrapolate findings from the Italian experience to apply directly to the UK, in an attempt to facilitate the debate regarding the benefits but more importantly the potential harms of screening. Based on this fundamental assumption the numerical implications of false positive results and expected disqualifications from sport are discouraging. Of the potential 1,520,021 young athletes screened, 140,361 would require further investigations and for every life saved 791 athletes would be disqualified.4

However, the epidemiological study by Elston et al exhibits important limitations which may have influenced the results and underestimated the impact of screening in the prevention of sudden cardiac deaths (SCD) in athletes and the population as a whole. The authors consider as post-screening period the first 23 years of screening (1982-2004), claiming that this may provide a more realistic picture, as it includes the period when screening mechanisms and expertise were developed and the full potential of screening
is unlikely to have been realised. Consequently, the reported post-screening incidence of sudden cardiac death is quoted as 1.57/100,000 person-years. This estimate is two fold higher than the reported incidence by Corrado et al. of 0.87/100,000 person-years during the late screening period (1993-2004) and four fold higher than the reported incidence of 0.43/100,000 person-years in the 2001-2004 period. Although a longer time period may offer epidemiologically more robust results, it is important to acknowledge that the latter figure of 0.43/100,000 person-years is likely to provide a more accurate estimate of the real potential of screening which is reinforced by the fact that the incidence of SCD plateaus during the 2001-2004 period and is likely to have remained so during the proceeding years.

Furthermore, Elston et al. underestimate the incidence of sudden cardiac death in young (14-35 years old) individuals in the UK. A recent study analysing the office of national statistics data indicates around 400 sudden cardiac deaths per year in the UK in this age group, which is likely to be an underestimate of the true incidence given the experience from previous prospective epidemiological studies within the UK and potential misclassifications of sudden cardiac deaths as epilepsy or accidental drowning.  

The study also fails to take into account current screening experience in the UK. Our own experience of screening highly trained athletes, using the Italian model, indicates a lower false-positive rate of 3.7%, compared to 9% by Corrado et al. This is most likely to reflect the differences in interpretation of
an abnormal ECG since in our practice, isolated large QRS complexes, borderline right axis deviation, a borderline prolonged QTc$^9$ and T-wave inversions in the right precordial leads in athletes <16 years old$^{10}$ would not be indications for further investigations in asymptomatic athletes in the absence of a family history of premature cardiac disease or sudden cardiac death. Similarly, there is no evidence that athletes with hypertension who continue to exercise are at risk of a fatality and the significance of mitral valve prolapse and isolated ventricular extra-systoles in the aetiology of sudden death is debatable. Therefore such athletes should not be considered to be at risk of sudden death and would not be advised to refrain from exercise. Conversely, the UK is more ethnically diverse that the Veneto region of Italy. In particular, there are significantly more athletes of Afro-Caribbean origin in the UK who are known to exhibit bizarre repolarisation electrical changes and may generate a significant number of false positive results.

In a prospective and on-going pilot study involving over 8000 athletes, conducted by the charitable organisation Cardiac Risk in the Young a potentially fatal disorder is identified in 0.3%. This figure is not dissimilar to the Italian data however the false positive rate in this study is less than 4% (unpublished data). Should one consider treatable conditions such as Wolff-Parkinson-White syndrome and right ventricular outflow tract ventricular tachycardia, then the permanent disqualification rates and the number of athletes disqualified for every life saved would be reduced dramatically. Although the precise false negative rate is unknown a mean 8-year follow up had identified only 1 athlete who suffered a sudden cardiac death from an
anomalous coronary artery disease, a disorder that cannot be identified with 12-lead ECG. Such prospective screening programmes are crucial to solving the debate and providing the British perspective relating to the cardiac screening of asymptomatic young athletes.

Finally, Elston et al. places particular emphasis on “minor harms” such as elevated anxiety caused by false positive results. Studies from established screening programs indicate that individuals with a false positive result may experience considerable anxiety until further investigations provide reassurance, which highlights the need for prompt evaluation of athletes who fail the initial screening. However, an apprehensive approach over long term psychological scarring of athletes with an initial false positive result requiring further detailed investigations is not justified since evidence from the same studies indicate that in the context of a well organised screening program with expert psychological support, there is no significant long term psychological burden.3

The financial constraints within the National Health Service, the priority in apportioning the budgets in reducing deaths from myocardial infarction, stroke and neoplastic disorders, the lack of expertise and the lack of robust cost effectiveness studies means that a nationwide screening of all young individuals participating in competitive sport cannot be currently implemented. Benevolent pragmatists advocate raising awareness of the risk of sudden cardiac death in sport and screening only those with a family history of hereditary cardiac disorder or symptomatic manifestation of cardiac disease.
Such a strategy however, will deny most athletes from being screened and fail to identify up to 80% of athletes at risk of sudden death. These limitations should prompt the development of a collaborative scheme between the Government, charity organisations such as CRY and sporting bodies to provide an initiative to offer cost effective screening with 12-lead ECG for athletes who chose to be screened for their self-protection.

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**Competing interest statement**

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